

DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Feasibility of a Nationwide Program for the Identification and  
Delineation of Hazards from Mud Flows and Other Landslides

Chapter C. Priority U.S. Areas for the Delineation of  
Susceptibility to Mud Flows and Other Landslides

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Geological Survey editorial standards and stratigraphic nomenclature.

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## Chapter C

### PRIORITY U.S. AREAS FOR THE DELINEATION OF SUSCEPTIBILITY TO MUD FLOWS AND OTHER LANDSLIDES

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#### Introduction

The establishment of operational priorities for a nationwide program of landslide-hazards identification and delineation should result only after comprehensive consideration of a wide range of technical, demographic, and economic purposes. Technical considerations suggest that priority should be assigned to areas according to the likelihood that potentially hazardous landslides (including mud flows) will occur in the greatest numbers and with the greatest frequency. Demographic concerns indicate that priority should be assigned to areas according to the likelihood that large numbers of people and their property are placed at risk from potentially hazardous landslides. Economics considerations might include the distribution of "mudslide" insurance policy-holders, some evaluation of the relative potential for "disaster" in different areas, concern for lenders' financial interests in new housing developments in hillside areas, or the needs of regulatory agencies for technical information. The scope of the present study permits only a superficial attempt to address some of these concerns, and allows inadequate consideration of Alaska, Hawaii, Puerto Rico, and other "overseas" U.S. areas that are also subject to significant hazards from mud flows and other landslides. Therefore, the ranking of priority areas suggested in this chapter represents the preliminary views of the author from a perspective that emphasizes regional variations in landslide susceptibility, and is subject to modification and revision.

There is a clear overlap in interest between FEMA concerns for information on the distribution of hazards from mud flows and other landslides and the mission of the U.S.G.S. to conduct research on the distribution and causes of different kinds of landslides. Several other Federal agencies also have objectives that include needs to identify and delineate potential landslide hazards on (or from) public lands, in public transportation corridors, and for conservation of land resources. FEMA concern about the identification of "mudslide" hazards for the purposes of the NFIP also probably shares some priority areas with those where needs for disaster assistance might be anticipated. Certainly, in the process of identifying areas susceptible to hazards from debris flows (mud flows), many areas susceptible to hazards from other kinds of landslides will also be identified.

#### Population Concentration, Distribution and Relative Risk from Mud Flows (Debris Flows) and Other Landslides

Although the suburban populations of the Los Angeles, San Francisco Bay, and Salt Lake City areas come to mind immediately when considering the distribution of potential hazards from debris flows and other landslides, it must be remembered that these communities also include many densely-populated flat-lying areas where the landslide potential is virtually nil. Conversely,

many mountain valley communities that might be considered "rural" when measured in units of persons-per-square-mile are constrained by their surroundings to a narrow strip of land, often above a flood plain and below a steep "unbuildable" slope. Therefore, the population at risk in many "rural" communities in the Appalachian Plateau, the Blue Ridge, and the central Rocky Mountains may be comparable in total numbers to that in some metropolitan areas that are more widely recognized as vulnerable to landslide damage.

#### Priorities for Hazards Identification, All Landslides

For a nationwide landslide-hazards reduction program, such as that described in USGS Circular 880 (USGS, 1982, p. 34), "the major population centers in regions of highest landslide incidence should be designated highest priority." Circular 880 (USGS, 1982, p. 35-37) also ranks the need for hazards delineation in three major U.S. landslide areas as:

1. West Coast region,
2. Appalachian region, and
3. Rocky Mountain region.

The rankings reflect concern for metropolitan areas in regions of high landslide susceptibility and for areas where cities are rapidly expanding onto landslide-prone hillsides. National lifelines (transportation corridors) and critical facilities such as major dams, reactor sites, aqueducts, airports, canals, energy-production centers, military sites, and others, are also priority areas for concern regarding mud-flow and other landslide hazards. Mountainous terrain in national parks and other recreational areas, where seasonal use exposes vacationers and hikers to hazards from landslides should be included in any National program. The extent of landslide hazards also should be delineated in areas where critical energy, mineral, and timber resources are being extracted, with consideration for cost-effective extraction of the resources and their transportation to markets, and for planning post-extraction uses of the land surface. Priorities for the delineation of areas susceptible to hazard from submarine landslides need to be established for identifying shoreline areas that might be at hazard from landslide-generated sea waves, and for identifying subsea areas where offshore structures (such as oil-well platforms or pipelines) might be endangered by landslides on the sea floor.

#### Priorities for Identifying Hazards from Mud Flows (Debris Flows)

Prominent mud-flow (debris-flow) disasters have occurred in recent years in association with rainstorms, snowmelt, and flooding in southern California, in the San Francisco Bay Region and adjacent parts of central California, along the Wasatch Front in Utah, along the steep eastern front of the Sierra Nevada in California and Nevada, in the Johnstown, Pennsylvania, area of the Appalachian Plateaus, and in Nelson County, in the Blue Ridge geomorphic province of Virginia. Clearly, these areas and similar settings in the same geomorphic provinces are susceptible to the occurrence of similar hazardous events. Geologic evidence and reports of sporadic, individual debris flow

events indicates that debris flows are common recurring events in other areas as well, including urban, suburban, and rural parts of the Puget Sound area, Washington, as well as rural and recreational communities in the Basin and Range province of Nevada, the Sierra Nevada Mountains of California and Nevada, and the Colorado Rockies. There seems little dispute that events such as these are included within the scope of the "mudslide" provision of the NFIP.

A preliminary ranking among major regions of the U.S., suggested on the basis of the areal extent affected by past events and the frequency with which similar events have occurred in the regions, follows:

1. Southern California -- especially the rapidly developing areas along the south flank of the San Gabriel and San Bernardino Mountains, and in mountain valleys and hillside sites in the San Gabriel, Santa Monica, Santa Ana, Topatopa, and Santa Ynez Mountains, including several lower foothill hillside areas. Major debris-flow events can be expected to occur at intervals of 2 to 12 years.
2. Central and northern California -- especially the Coast Range mountain hillsides of the Marin County peninsula, the Santa Cruz Mountains, the Berkeley Hills, and the northern Santa Lucia Range. Major debris-flow events can be expected to occur at intervals of 7 to 20 years.
3. Wasatch Front, Utah -- especially in communities of the greater Salt Lake City metropolitan area, extending from Ogden to Provo. Major debris-flow events can be expected to occur at intervals of from a few years to a few tens of years.
4. Appalachian Mountains-Blue Ridge province -- especially at concentrations of rural population at the mouths of steep drainage basins. Major debris-flow events can be expected to occur at intervals of from about 10 years to several 10's of years.
5. Eastern and central Appalachian Plateaus -- especially at concentrations of rural population extending along upper edges of flood plains, where flood plains abut steep valley sides. Significant debris-flow events can be expected to occur at intervals of from about 10 years to several 10's of years.
6. Central Rocky Mountains, including the eastern front in the Boulder-Denver-Colorado Springs area -- should include mountain valleys and hillside areas undergoing rapid development for recreational purposes.
7. Cascade Range -- particularly adjacent to Puget Sound-Willamette Valley population concentrations. Special attention should be given to potential for debris flows initiated on the steep sides of active and dormant Cascade volcanoes.
8. Northern Rocky Mountains -- especially areas of rapid development for recreation in the vicinity of Jackson, Wyoming, and areas of mineral and energy resources development in Wyoming and Idaho.

9. Southern and southeastern Alaskan coastal communities, many of which are perched on narrow strands between high mountains and the ocean, where population centers are constrained to areas of potential hazard.
10. Selected areas of heavy recreational use in the Basin and Range province in Nevada, many of which are also subject to hazard from flash flooding in canyons and on alluvial fans.
11. Selected areas of heavy recreational use in the Adirondack, Green, and White Mountains of the New England Highlands province in New York, Vermont, New Hampshire, and Maine.

The foregoing rankings are not comprehensive; however, they serve to demonstrate that the potential for hazards from mud flows (debris flows) and other landslides is nationwide. Additional study would be required to establish a more comprehensive ranking.

#### Reference

- U. S. Geological Survey, 1982, Goals and tasks of the landslide part of a ground-failure hazards reduction program: U. S. Geological Survey Circular 880, 49 p.